YELLOWSTONE WOLF PROJECT

ANNUAL REPORT 1999

Yellowstone Wolf Project

Annual Report
1999

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Background

Although wolf packs once roamed from the Arctic tundra to Mexico, they were regarded as dangerous predators, and gradual loss of habitat and deliberate extermination programs led to their demise throughout most of the United States. By 1926, when the National Park Service (NPS) ended its predator control efforts, there were no gray wolf (*Canis lupus*) packs left in Yellowstone National Park.

In the decades that followed, the importance of the wolf as part of a naturally functioning ecosystem came to be better understood, and the gray wolf was eventually listed as an endangered species in all of its traditional range except Alaska. NPS policy calls for restoring native species that have been eliminated as a result of human activity if adequate habitat exists to support them and the species can be managed so as not to pose a serious threat to people or property outside the park. Because of its large size and abundant prey, the greater Yellowstone area was identified in the recovery plan as one of three areas where the recovery of wolf populations had a good chance of succeeding.

The goal of the wolf restoration program is to maintain at least 10 breeding wolf pairs in greater Yellowstone, as it is for each of the other two recovery areas in central Idaho and northwestern Montana. Once 10 pairs are established and reproduce in each of the three recovery areas for three successive years, the gray wolf can be removed from the list of endangered species in Idaho, Montana, and Wyoming. The U.S. Fish and Wildlife Service (FWS), which has the primary responsibility for ensuring compliance with the Endangered Species Act, oversees the multi-state recovery program. In Yellowstone, two NPS wildlife biologists are dedicated full-time to the project, with one technical assistant and from two to six seasonal volunteers.

Following an extended period of public planning and input, wolf restoration to the greater Yellowstone area (GYA) began in 1995, when 14 wolves were brought to the park from Alberta, Canada, held in acclimation pens for 10 weeks, and then released. Initial founder wolves, named for the geographic locales at which they were acclimated, were the Crystal Creek, Rose Creek, and Soda Butte packs on Yellowstone's northern range. In 1996, an additional 17 wolves were transplanted from British Columbia and released in more widespread locations throughout the park. In 1995–96, a companion effort to restore wolves to central Idaho occurred, using a simpler technique without acclimation. Although the original plan, outlined in *The Reintroduction of Gray Wolves to Yellowstone and Central Idaho, Final Environmental Impact Statement* (1994), called for annual translocations from Canada for up to five years, additional transplants were deemed unnecessary by 1997 because the founder wolves had higher reproduction, lower mortality, and less movement from the GYA than was originally expected.

Wolves reintroduced into Yellowstone were classified by the FWS as "nonessential experimental" under section 10(j) of the Endangered Species Act and are managed under special rules that permit managers flexibility in addressing wolf conflicts with livestock and other wildlife management goals. It was anticipated that as the wolf packs established their territories, some would hunt and/or reside outside the park on other public or private land, and that some of the 412,000 livestock in the GYA would be preyed upon. The special rules contained provisions for addressing the possibility of conflicts with livestock.

To facilitate monitoring and research, all of the wolves brought from Canada were radio-collared before release, and the intention is for YNP to maintain radio collars on up to half of the wolves in the population. Wolf project staff monitor population dispersal, distribution, reproduction, mortality, and predation on ungulates. Monitoring and management activities for the first two years of the project are documented in *The Yellowstone Wolf Project, Biennial Report 1995–96.* Subsequent project activities are presented in annual reports, including this one.

1999 Summary

At the end of 1999, at least 118 wolves were present in the greater Yellowstone area (GYA). Although at least 64 pups were born in the GYA in 1999, only 38 survived to the end of the year. There were 14 known wolf mortalities, and the fate of 18 other wolves was unknown; they may have died or left the ecosystem. The total number of wolves in the GYA at the end of 1999 was only six more than in 1998.

As was the case at the end of 1998, 11 wolf packs were present in the GYA; there were also at least 17 wolves traveling alone or in small groups without established territories. Three of the packs had territories that lay entirely outside YNP. Ten of the packs produced a total of 12 litters; an additional litter was born to a wolf pair that was not considered part of an established pack. There were no new packs that could be counted toward wolf population recovery in 1999. To meet the requirements for delisting the wolf as an endangered species, 10 breeding pairs with at least two pups-of-the-year that survive until December 31 are needed in each of the three recovery areas for three consecutive years. Because one pack did not breed, and due to alpha male and pup mortalities that had occurred by year's end, only six packs had breeding pairs that counted toward recovery in the GYA, the same number of packs that counted in 1998.

In 1999, Yellowstone National Park staff began sharing the responsibility for GYA wolf management with the U.S. Fish and Wildlife Service, which monitored wolves residing primarily to the south and east of the park. This annual report will continue to include data on all wolves monitored within the ecosystem; however, certain details regarding movements and activities will only be provided for packs residing primarily within the park.

In addition to 26 pups that were born in the spring of 1999 and died of natural causes, 14 wolves are known to have died in the GYA in 1999: 6 adults, 2 yearlings, and 6 of the pups that were born in 1998. Ten of the losses were human caused: eight were due to control actions for livestock depredation; one wolf died as the result of a collision with a vehicle; and one had to be euthanized as the result of a capture-related injury. One wolf probably died of disease, two were killed by other wolves, and the cause of one death remains unknown.

This was the second year that wolves in YNP were systematically darted from a helicopter and captured in order to maintain a sufficient number of radio collars on the population for monitoring purposes. As a result of this effort, 23 wolves from seven packs in YNP received radio collars; the total number of collared wolves at the end of 1999 was 47.

Within the park, wolves continued to prey mostly on elk (87% of total wolf kills). Other known prey killed by wolves included 14 bison (4%), 7 moose (2%), 2 mule deer (<1%), 3 coyotes (1%), 1 short-eared owl (<1%), and 1 wolf (<1%). The composition of elk kills was 44% calves (0–12 months), 21% cows, 22% bulls, 4% adults of unknown sex, and 9% elk of unknown age and sex. Predation rates were monitored again in early (mid-November–December) and late (March) winter. As in previous years, kill rates were lower in the early winter (a kill every two to three days) than in the late winter (a kill every one to three days). Warm temperatures and below average snowfall early in the winter (1998) provided favorable conditions for ungulates; later in the winter, snow accumulations approached normal levels.

Collaborative studies of wolf genetics continued in 1999, involving the Diversa Corporation, the Celera Agen Corporation, Johns Hopkins University, the Sidney Kimmel Cancer Center, and the Yellowstone Center for Resources. Where polygyny occurred, multiple litters were confirmed to be fathered by the alpha male of each pack. Pups were also documented breeding in the wild—the first report of its kind.

The Yellowstone Wolf Project was also involved in collaborative studies on wolf-cougar interactions, wolf-coyote interactions, wolf-elk relationships in the Madison-Firehole, wolf stress hormones, wolf-scavenger relationships, and wolf–cougar–grizzly bear–human hunter interactions. Five graduate students partially supported by the Yellowstone Wolf Project neared completion of their studies and expect to graduate in 2000.

Twenty-two volunteers worked a total of 15,408 hours for the Wolf Project in 1999.

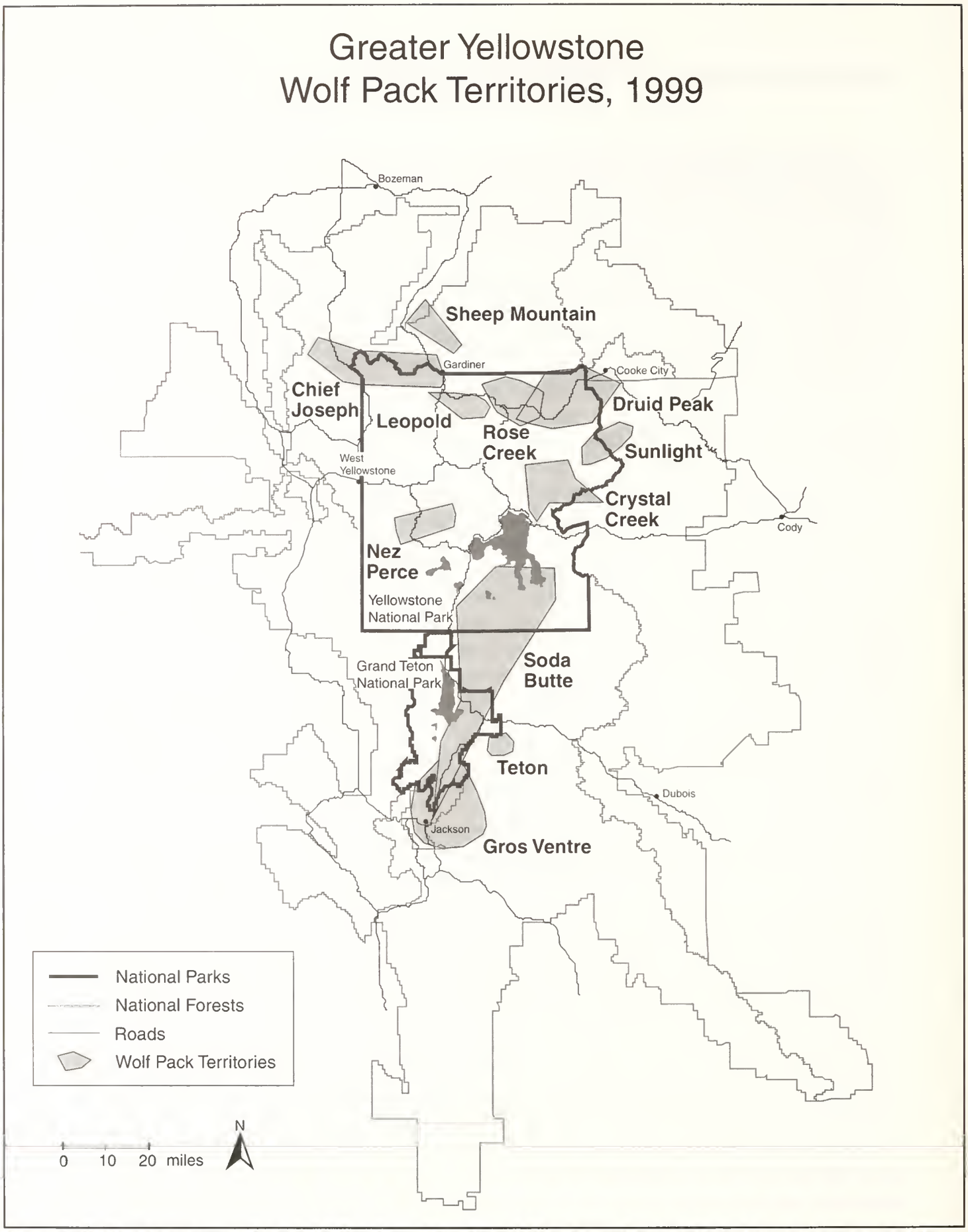


Figure 1. Wolf pack territories. A total of 118 wolves—11 packs and 17 wolves without established territories—occupied the GYA in 1999.

Douglas Smith

Wolf #7, alpha female of the Leopold pack, near Geode Creek. She is one of the few remaining founder wolves. Having evaded capture the previous two years, she received a new radio collar in 1999.

The Yellowstone Wolf Population

Population Status and Reproduction

From 1995 through early 1999, Yellowstone National Park (YNP) staff were responsible for wolf monitoring throughout the GYA. Beginning in February 1999, the U.S. Fish and Wildlife Service stationed two people in Lander, Wyoming, to assist with wolf monitoring and management, especially for wolves residing primarily to the south and east of the park. Although this annual report will continue to include data on all wolves monitored within the ecosystem, certain details regarding movements and activities will only be provided for packs residing primarily within the park.

After a period of rapid increase during the first three years after reintroduction, the growth in the GYA wolf population slowed in 1999 (Fig. 2). At year's end, the population numbered approximately 118 individuals, 101 of which belonged to 11 packs (Table 1). Three packs resided entirely outside YNP: two in Wyoming (Gros Ventre and Teton packs) and one in Montana (Sheep Mountain pack) (Fig. 1). There were no new packs that could be counted toward wolf population recovery in 1999. To meet the requirements for delisting the wolf as an endangered species, 10 breeding pairs with at least two pups-of-the-year that survive until December 31 are needed in each of the three recovery areas for three consecutive years. While eight of the GYA packs had breeding pairs that would count toward recovery, only six of these packs had two pups that survived to the end of the year. Of the five packs that did not count toward delisting, one pack did not breed, the alpha male in two packs died before year's end, and two packs had only one pup surviving as of December 31.

Table 1. Wolves in the GYA as of December 31, 1999.

Pack	Adults	Yearlings	Pups	Total
Druid Peak	6	0	2	8
Rose Creek	10	unknown	6	16
Leopold	10	unknown	1	11
Crystal Creek	12	unknown	1	13
Chief Joseph	5	unknown	3	8
Nez Perce	8	unknown	5	13
Soda Butte	3	0	0	3
Sheep Mountain	2	4	3	9
Teton	1	0	5	6
Gros Ventre	3	0	2	5
Sunlight Basin	2	0	7	9
Others	14+	0	3	17
Total	**76+**	**4+**	**38**	**118+**

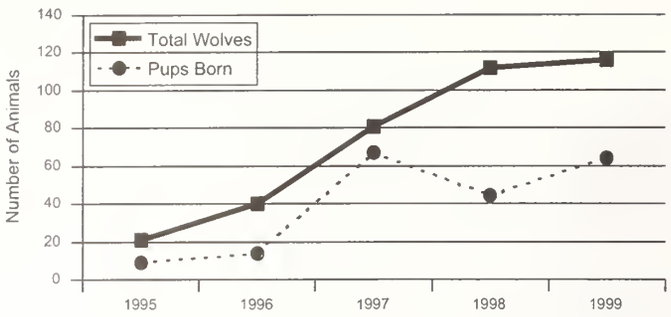


Figure 2. Wolves in the GYA, 1995–1999.

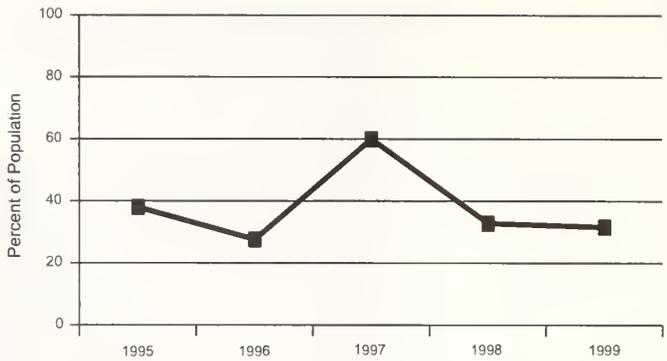


Figure 3. Percentage of pups in the GYA wolf population, 1995–1999.

At least 64 pups were born in the GYA in 1999: 12 litters produced by 10 of the established packs, and one litter of three pups born to a wolf pair that is not considered part of an established pack. The only other established pack (Soda Butte) has not produced a litter since 1997. However, the Rose Creek pack had three breeding females, making 1999 the third consecutive year in which more than one Rose Creek female bred. The litters ranged in size from 1 to 7 pups and averaged 5.3 pups.

Only 38 (59%) pups were known to be alive at the end of 1999. This was the lowest annual rate of pup survival that has been recorded in the reintroduced GYA wolf population. (The survival rate ranged from 73% to 81% from 1996 through 1998.) At the end of 1999, only 32 percent of the GYA wolf population was pups, compared to an average of 38 percent for the period 1995 through 1999 (Fig. 3).

Five of the females that bred in 1998 used the same den sites that they did in 1999. Three packs denned for the first time in 1999. Remote telemetry was again used to monitor two den sites on Yellowstone's northern range. Wolf pups in YNP were born between April 2 and April 27; their average birth date was April 13.

Population Movements and Territories

Wolf ranges in the GYA expanded very little in 1999, and the territories of the established packs remained essentially the same (Fig. 1). The Chief Joseph II pack became autonomous from the Chief Joseph I pack and was renamed the Sheep Mountain pack. The Chief Joseph I pack was renamed the Chief Joseph pack. They ranged north of the park in the Gallatin National Forest. One new pack formed north of the park, but the alpha female died of unknown causes in late 1999. A disperser from the Rose Creek pack, she was the only collared individual in the group. The fate of her uncollared mate and their pups is unknown.

Several wolves dispersed from established packs late in 1999, but it is unknown whether any of these individuals will form new packs. Areas of new wolf activity included the Tower Junction and Sepulcher Mountain areas in northern YNP, the Absaroka-Beartooth Wilderness east of YNP, and the Gallatin National Forest northwest of YNP. (Wolves in these areas are included in the "Others" category in Table 1.)

Wolf pack territory sizes ranged from 88 km^2 (Sunlight Basin pack) to 2,419 km^2 (Soda Butte pack). Average territory size was 891 km^2.

Douglas Smith

Members of the Crystal Creek pack.

Table 2. Known Wolf Mortalities in the GYA During 1999.

Wolf	Pack	Age	Sex	Cause of Death
043M	Soda Butte	Adult	Male	Wolves
078F	Rose Creek	Adult	Female	Unknown
082M	Rose Creek	Adult	Male	Unknown
123M	Soda Butte	Adult	Male	Suspected to be Wolves
133M	Teton	Adult	Male	Vehicle
160F	Rose Creek	Pup	Female	Human
165M	Sheep Mountain	Adult	Male	Control Action
167F	Sheep Mountain	Yearling	Female	Control Action
168F	Sheep Mountain	Yearling	Female	Control Action
182M	Sheep Mountain	Pup	Male	Control Action
183F	Sheep Mountain	Pup	Female	Control Action
184F	Sheep Mountain	Pup	Female	Control Action
185M	Chief Joseph	Pup	Male	Control Action
186M	Chief Joseph	Pup	Male	Control Action

Mortalities

In addition to pups that died during the spring and summer, 14 wolves are known to have died in the GYA in 1999: 6 (43%) adults, 2 (14%) yearlings, and 6 (43%) pups (born spring 1998) (Table 2). Ten of the losses were human caused: eight were due to control actions for livestock depredation; one was the result of a collision with a vehicle; and one was euthanized as the result of a capture-related injury. One wolf probably died of disease, two were killed by other wolves, and the cause of one death remains unknown. Ten of the deaths occurred outside the park. Since 1995, most wolf mortalities have been caused by humans, through management actions, illegal killings, or collisions with vehicles (Fig. 4).

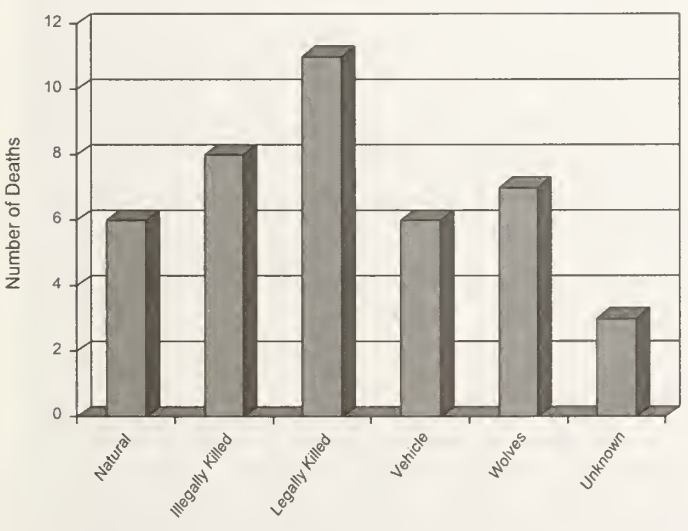


Figure 4. Cause of mortality for radio-collared wolves in the GYA, 1995–1999.

Pack Summaries

Leopold Pack

Similar to previous years, this pack primarily used the Blacktail Deer Plateau and Swan Lake Flats area in northern YNP. They reproduced for the fourth consecutive year, and used the same den site for the third year in a row. Only one pup from the 1999 cohort survived, leaving a total of 11 wolves in the pack at year's end.

Chief Joseph Pack

Considered separate from the Chief Joseph II (renamed Sheep Mountain) pack in 1999, the Chief Joseph pack ranged the northwest portion of the park, as it had from 1996 to 1998. They reproduced a third consecutive year and had six pups. Two pups were killed during a livestock control action that was prompted by their depredation on six sheep in Tom Miner Basin north of the park. This pack totaled eight wolves at the end of 1999.

Rose Creek Pack

Another pack with a stable territory, the Rose Creek pack occupied the lower Hellroaring and Slough creek watersheds in the central portion of YNP's northern range. Together with the Crystal and Soda Butte packs, the Rose Creek pack is among the oldest in the GYA. As of early 1999, each of these packs still had their original alpha female from the 1995 reintroduction effort. Number 9, however, who has made the greatest genetic contribution to the GYA wolf population, was forced out of the pack in

Douglas Smith

A rare summer photo of an uncollared adult gray wolf, the probable mate of #78, a female disperser from the Rose Creek pack. One of their pups is partially hidden behind the sagebrush.

late 1999. Her daughter (uncollared #18) has assumed the alpha female role. Field observations indicated that #18 was dominant to #9 before #9 dispersed. Number 9 now resides east of the park in the Absaroka-Beartooth Wilderness and is loosely affiliated with three other wolves. Three Rose Creek females (#9, #18, and #78) produced litters in separate dens during 1999. Number 78 produced five pups, three of which were known to have survived to the end of the year. However, #78's group never rejoined the Rose Creek pack after denning. Most non-alpha wolves in this pack focused their activity around #18's den and her seven pups. Number 9 produced six pups at a new location and raised them with little support from the core pack members. All Rose Creek wolves, except #78's group, used their traditional Buffalo Plateau rendezvous site. Only six total pups from #18 and #9 survived to year's end. Totaling 16 individuals, this is still the largest GYA pack.

Druid Peak Pack

The last of the "big three" (Leopold, Rose, and Druid—called the big three because they are so visible and so much is known about them), the Druid Peak pack lived in Lamar Valley. From 1995 through the end of 1999, approximately 50,000 visitors had seen this pack, arguably making them the most viewed wolf pack in the world. They had one litter of six pups, but only two survived. Number 42 (#40's subordinate sister) also denned, but it is unknown if she whelped or experienced a pseudopregnancy. Shortly after #42 localized near a den hole, #40 attacked #42, which could have affected any pups she might have been tending. After #42 abandoned her den hole, an examination of the area never produced any evidence that she had pups. Afterwards, #42 rejoined the main pack. The Druid Peak pack comprised eight wolves at the end of 1999.

Crystal Creek Pack

Carving out a year-round existence in Pelican Valley, the Crystal Creek pack has learned how to kill bison. The Pelican Valley area, which supports many elk during the snow-free portion of the year, supports very few during the winter. However, several hundred bison live in Pelican Valley, no matter how severe the winter. When bison weaken during late March due to protracted winter conditions, the Crystal wolves increase their frequency of bison kills. Last year, wolf project field workers observed two bison being killed by the Crystal Creek wolves—both in March. Ten and 14 wolves were involved with the kills, suggesting that it may take more wolves to bring down a bison than it does an elk. Only one pup was observed in the Crystal Creek pack, which had a total of 13 wolves at the end of 1999.

Soda Butte Pack

Ranging over the largest area of any pack in the GYA, the Soda Butte pack's territory ran from Jackson Hole to Hayden Valley in YNP. They did not reproduce for the second consecutive year. Alpha female #14 was still without a mate in late 1999, even though she traveled

briefly with male #104. About the time #14 was observed with #104, four other pack members (#44, #123, #124, and #126) dispersed. Both #123 and #124 perished, #123 in a fight with the Crystal wolves and #124 to unknown causes. Number 44 and #126 eventually reunited with #14 to form a pack of three at the end of the year.

Nez Perce Pack

Ten wolves were brought from northwest Montana in late 1996 and released in YNP in early 1997. However, eight of the wolves were subsequently removed due to conflicts with livestock. The other two wolves, #70 and #72, survived and are still members of this pack, which resides in the Madison-Firehole area of the park. This pack has also killed bison, and it is the only pack in the GYA that is comprised entirely of gray-colored wolves. In 1999, this pack chose a new den site and produced a litter of five pups, all of which apparently survived through the end of the year, bringing the total pack size to 13 wolves.

Status of Reintroduced Wolves in Yellowstone

Wolves Released in 1995 (from Alberta, Canada)

Wolf #	Pack	Fate/Current Whereabouts
#2 M	Leopold	Alpha male of Leopold pack.
#3 M	Crystal Creek	Dead—control action (Wildlife Services).
#4 M	Crystal Creek	Dead—intraspecific conflict with Druid Peak pack.
#5 F	Crystal Creek	Former Crystal Creek alpha female. Current status unknown.
#6 M	Crystal Creek	Dead—natural accident (encounter with stick).
#7 F	Leopold	Alpha female of Leopold pack.
#8 M	Rose Creek	Dead—apparently from natural causes. Necropsy results pending.
#9 F	Rose Creek	Former Rose Creek alpha. Living east of YNP with a black male adult.
#10 M	Rose Creek	Dead—illegally shot. Former alpha male of Rose Creek pack.
#11 F	Soda Butte	Dead—illegally shot.
#12 M	Soda Butte	Dead—illegally shot.
#13 M	Soda Butte	Dead—unknown (probably natural death).
#14 F	Soda Butte	Dead—necropsy results pending (probably killed by moose).
#15 M	Washakie	Dead—control action (Wildlife Services). Former Soda Butte wolf.

Wolves Released in 1996 (from British Columbia, Canada)

Wolf #	Pack	Fate/Current Whereabouts
#26 F	Washakie	Dead—control action (Wildlife Services). Former Nez Perce wolf.
#27 F	Nez Perce	Dead—control action (Wildlife Services). Former alpha female.
#28 M	Nez Perce	Dead—illegally shot. Former alpha male.
#29 M	Gros Ventre	Alpha male of Gros Ventre pack, GTNP. Former Nez Perce wolf.
#30 F	Thorofare	Dead—natural accident (avalanche).
#31 M	Druid Peak	Dead—illegally shot.
#32 F	Crystal Creek	Dead—hit by truck on U.S. Highway 191.
#33 F	Chief Joseph	Alpha female of Chief Joseph pack.
#34 M	Chief Joseph	Alpha male of Chief Joseph pack.
#35 M	Thorofare	Dead—intraspecific conflict with Soda Butte pack.
#36 F	Blacktail	Dead—natural accident (probably thermal burns).
#37 F	Nez Perce	Dead—control action (Wildlife Services).
#38 M	Druid Peak	Dead—illegally shot.
#39 F	Druid Peak	Dead—illegally shot.
#40 F	Druid Peak	Dead—former Druid Peak alpha (probably killed by #42, her sister).
#41 F	Sunlight Basin	Alpha female of Sunlight Basin pack. Former Druid Peak wolf.
#42 F	Druid Peak	Presumed new alpha female of Druid Peak pack.

Wolf Dispersal

Graduating from the Pack

Michal S. Murri

Although the lone wolf of lore is seen as the epitome of rugged individualism, this is almost certainly a cultural myth. Biologists regard the lone wolf as an animal that is performing the biologically necessary act of dispersal. Wolves are complex social animals and, for the most part, do not like to be alone. The social bonds formed in the pack between mated adults and their offspring are very strong. Why, then, would any wolf venture into the unknown and risk starvation, isolation, or attack by wolves in other territories?

Data collected from the inception of the Yellowstone Wolf Project in the spring of 1995 through the end of 1999 may help answer this question. Thirty-six wolves—18 females and 18 males—are documented as having left their original packs during this time. One factor in the timing of this dispersal may be that wolves attain sexual maturity at 22 months of age. Of the 36 dispersers, 18 were yearling wolves and 10 were two-year-olds. Of the remaining eight dispersals, two were pups (<12 months of age), two were three-year-olds, and four were adults of unknown age.

Social pressures caused by food limitation may force younger wolves of breeding age to disperse. In addition, hormonal urges may drive a young wolf to seek a mate outside its natal pack, as that may be its only reproductive opportunity. In Yellowstone, 17 of the 36 wolves that dispersed bred in their new packs. The annual breeding season in February is a stressful time of year for wolf packs. This may explain why 69 percent (27 of 39) of the dispersal events occurred between September and January. When dispersing wolves leave a pack at this time, it may reduce intrapack stress levels and allow the dispersing individual time to find its own mate. However, in the Superior National Forest, Dave Mech documented only 28 percent (5 of 18) of the dispersal events as occurring during that time of year.

Dispersal is also one of the mechanisms for creating genetic variability. While inbreeding exists in wolf populations, especially on Isle Royale, constant inbreeding may lead to genetic depression and the emergence of undesirable traits. A wolf that disperses has a greater opportunity to meet a wolf with a different genetic background. This mixing of genes produces healthier offspring with a greater chance of survival and subsequent ability to pass along their own genetic material. Dispers-

Wolf #147, a male that dispersed from the Chief Joseph pack, in Lamar Valley.

ing wolves can reach isolated populations of wolves hundreds of kilometers distant and contribute their genes to a population that may be suffering from genetic depression.

Dispersing wolves can also colonize areas that are devoid of other wolves yet offer suitable wolf habitat. Dispersal among the three Rocky Mountain recovery areas is critical to the long-term success of the reintroduction because it permits connectivity between wolf populations. It is hoped that dispersers will link these three areas to form a "metapopulation." In early 1999, a Yellowstone-born adult male (#132) dispersed to Idaho, creating the first natural link between the two ecosystems.

Possessing an efficient gait, a wolf can travel at 8 kilometers an hour for hours on end, and a wolf pack may cover 15 to 50 kilometers per day. The Wolf Project has 29 data sets of 16 males and 13 females with known distances between a dispersing wolf's original pack and its final location. Males have dispersed an average distance of 87 km and females an average of 64 km. The shortest recorded dispersal distance was that of #21, the current alpha and breeding male for the Druid Peak pack. Reared in the Rose Creek pack, #21 traveled only 16 km (measured from the center of his natal territory to the center of his adult range) to join the Druid Peak pack. Wolf #132 traveled the furthest during his dispersal, covering 356 km. These are straight-line distances; the actual distance traveled by a dispersing wolf is probably much greater.

While dispersal events constitute an important part of the Yellowstone wolf population dynamic, there is another noteworthy phenomenon. After they become sexually mature, some wolves become "biders" within their original pack rather than dispersers. A bider is so named because it bides its time, waiting for an opportunity to climb the social ladder within the pack. Number 18 of the Rose Creek pack, who assumed the alpha female position last spring, is a good example. She has enjoyed the benefits of an established social order while passing along her genes within her original pack. These benefits include not having to risk establishing a territory of her own (and running afoul of an established pack nearby) and having a pack in place to provide food and social support to her offspring. However, to avoid incest, biders typically must wait to breed until their opposite sex parent dies and is replaced by a new, unrelated wolf from a different pack.

Wolf Capture and Collaring

This was the second year that a systematic radio-collaring effort took place in YNP. The primary purpose of collaring is to permit monitoring of wolf population dynamics, which is needed to document population recovery for the purpose of delisting the wolf as an endangered species. Twenty-four wolves from seven packs were darted from a helicopter in January and February. The age composition of these wolves was 13 pups (54%), 7 subadults (29%), and 4 adults (17%). Ten males and 14 females were captured. The packs and wolves captured and handled were as follows: four Leopold pups (3F, 1M); four Rose Creek pups (3F, 1M); two adults and one pup from the Druid Peak pack (2F, 1M); one pup and two subadults from the Chief Joseph pack (1F, 2M); one pup and one subadult from the Sheep Mountain pack (2M); two pups and one subadult from the Crystal Creek pack (2F, 1M); and three subadults and two adults from the Soda Butte pack (3F, 2M).

As a result of this effort, 23 wolves from seven packs received radio-collars; the total number of collared wolves at the end of 1999 was 47.

One wolf was hit in the leg by a dart, which produced a compound fracture. The two veterinarians who examined the animal both gave it a minimal chance of survival in the wild after treatment. This has been the only wolf that has had to be euthanized in 183 captures.

Wolf condition again appeared exceptionally good. The range of weights for all age and sex classes was 90–130 pounds. Adult females averaged 108 pounds. No adult males were captured. Male and female pups averaged 107 and 96 pounds, respectively.

William Campbell

Two Druid Peak wolves were tranquilized and fit with radio collars while scientific data were collected.

Douglas Smith

Data indicate that more bull elk are killed in late winter, when bulls are most vulnerable, than during other times of the year. Bull elk are especially common on the Blacktail Deer Plateau, where the Leopold pack killed this one.

Wolf Predation

Wolf-prey relationships were documented by observing wolf predation directly and by recording characteristics of wolf prey at kill sites. Wolf packs were monitored during two winter-study sessions, when wolves were intensively radio-tracked each day for 30 consecutive days during March and November–December. The Leopold, Rose Creek, and Druid Peak packs were monitored by two-person teams from the ground and from aircraft; the Chief Joseph, Crystal Creek, Soda Butte, and Nez Perce packs were monitored from aircraft only. Behavioral interactions between wolves and prey, predation rates, the total time wolves fed on their kills, the percentage of consumption of kills by wolves and scavengers, characteristics of wolf prey (*e.g.,* nutritional condition), and characteristics of kill sites were recorded and entered into a database. The abundance and sex-age composition of elk within wolf pack territories were also estimated from the ground and from airplanes.

Composition of Wolf Kills

Wolf project staff detected 110 definite and 206 probable kills made by wolves in 1999, including 276 elk (87%), 14 bison (4%), 7 moose (2%), 2 mule deer (<1%), 3 coyotes (1%), 1 short-eared owl (<1%), 1 wolf (<1%), and 12 unknown prey (4%). The composition of elk kills was 44% calves (0–12 months), 21% cows, 22% bulls, 4% adults of unknown sex, and 9% elk of unknown age and sex. Bison kills included nine calves, two cows, and three adults of unknown sex. Moose kills included two calves, two cows, and three adults of unknown sex. Most bison and moose were killed during late winter.

Winter Studies

During the March winter study, wolves were observed for 295 hours from the ground. The number of days wolf packs were located from the air ranged from 5 (Soda Butte pack) to 21 (Rose, Druid, and Sheep Mountain packs). Eighty-seven definite or probable wolf kills were detected, including 73 elk, 7 bison, 5 moose, 1 coyote, and 1 prey of unknown species. Among elk, 30 (41%) kills were calves, 15 (21%) were cows, 22 (30%) were bulls, 2 (3%) were adults of unknown sex, and 4 (5%) kills were elk of unknown sex and age. Packs that resided on the northern range averaged one ungulate kill every one to three days.

During the November–December winter study, wolves were observed for 265 hours from the ground. The number of days wolf packs were located from the air

ranged from 3 (Soda Butte pack) to 18 (Leopold pack). Forty-four definite or probable wolf kills were detected, including 34 elk, 2 mule deer, 1 coyote, 1 short-eared owl, 1 wolf, and 5 unknown prey. Among elk, 23 (67%) kills were calves, 5 (15%) were cows, 4 (12%) were bulls and 2 (6%) kills were elk of unknown sex and age. Packs that resided on the northern range averaged one ungulate kill every two to three days.

Wolf Management

Area Closures

To prevent human disturbance of young pups, visitor entry was closed to areas surrounding the dens of the Rose Creek (females #9 and #18) and Druid Peak packs (#40) from May 3 to June 30 and from April 16 to July 30, respectively. Closed areas were about four square miles and were centered around the dens. A no-stopping zone was also instituted along the road to Cooke City near the den of the Druid Peak pack to discourage visitors from parking their vehicles outside established turnouts and to keep them from stopping near wolves that were trying to cross the road near the den. Hiking trails in the vicinity of the Rose Creek and Druid closures remained open to visitors. The Daly Creek drainage southeast of the Daly Creek trail was closed to protect Chief Joseph pups from about April 15 to June 15. The trail and the area northwest of the trail remained open to hiking. Newborns at the den sites for the Leopold, Crystal Creek, and Nez Perce packs were protected from disturbance incidental to closures for the Blacktail (March 10 to June 30), Pelican Valley (April 1 to July 3), and Firehole (March 10 to about May 26) bear management areas.

Pen Removal

The wolf acclimation pens were removed from the Trail Creek and Fishing Bridge sites during late August 1999. Responsibility for the Trail Creek pen was transferred from the NPS to the U.S. Fish and Wildlife Service. The panels used to construct the pen were transported to the Flying-D Ranch near Bozeman, Montana, to support research on captive wolves with a history of depredation.

Wolf Depredation Outside the Park

Wolves killed 4 cattle, 13 sheep, 1 foal, and 6 dogs in the GYA during 1999. Although this is more than the total of 15 domestic animals killed by wolves in 1998, it is far fewer than the 72 losses that occurred in 1997. Eight wolves in the Chief Joseph and Sheep Mountain packs were killed during control actions in response to livestock losses; none were translocated.

Wolf Genetics Studies

Familial relationships among Yellowstone wolves were estimated using microsatellite analysis of DNA that was collected from live-captured or dead wolves, 1995 to 1999. Ninety free-ranging wolves born in nine different packs were genotyped at 23 loci. A wolf pedigree was constructed. Preliminary results suggested that immediately after reintroduction, Yellowstone wolves were more polygynous than in areas characterized by wolves in long-standing populations. This work is a collaborative effort with Eric Mathur and Dorris Hafenbradl at the Diversa Corporation, Janet Zeigle and Larry Joe at the Celera Agen Corporation, Dr. Karl Broman at Johns Hopkins University, Dr. Michael McClelland at the Sidney Kimmel Cancer Center, and John Varley and Sarah Stevenson at the Yellowstone Center for Resources.

Douglas Smith

Alpha female #7 and male #55 of the Leopold pack recover from capture and handling. Weighing in at 135 pounds, #55 was one of the larger wolves captured.

Douglas Smith

Almost immediately after a snowfall, the distribution and consistency of the snow changes, affecting wolves and their prey. In this photo, members of the Rose Creek pack near Slough Creek Campground walk on top of and break through the snow.

Projects by Graduate Students

Graduate Student: Amy Jacobs (Master of Science candidate)
Committee Chair: Dr. Rolf Peterson, Michigan Technological University
Title: Leadership: Ecological implications of social behavior in gray wolves
Project Narrative: This study examined the relationship between the breeding status of a wolf (*e.g.*, breeding male, breeding female, non-breeding wolf, etc.) and its importance within pack behaviors, such as travelling or hunting. This research will not only produce a definition of wolf leadership, but also examines the environmental circumstances under which wolves of different breeding status lead.
Project Activity in 1999: Amy assisted wolf project field operations and analyzed her leadership data.
Anticipated Completion Date: May 2000

Graduate Student: Dan MacNulty (Master of Science candidate)
Committee Chair: Dr. L. David Mech, University of Minnesota
Title: Hunting success of gray wolves and pursuit deterrence signals of elk in Yellowstone
Project Narrative: The factors influencing the elk hunting success of gray wolves were assessed. Data from 440 elk hunts and 91 kills indicated that factors related to the physical vulnerability of elk were most important in predicting wolf hunting success. Behavioral cues of the physical condition of elk, or pursuit deterrence signals were also described. Results suggested that elk used a head-high display in combination with a trotting gait to advertise their ability to escape and dissuade wolves from pursuit.
Project Activity in 1999: Dan completed his course work and began analyzing his data.
Anticipated Completion Date: September 2000

Graduate Student: Carrie Schaefer (Master of Science candidate)
Committee Chair: Dr. Rolf Peterson, Michigan Technological University
Title: Spatial and temporal variability of Yellowstone's northern range elk (*Cervus elaphus*) herd in wolf (*Canis lupus*) pack territories
Project Narrative: Population parameters were estimated for elk within wolf pack territories on Yellowstone's northern range. Between-observer variance in estimates of elk numbers and sex-age composition was negligible. The detection rate of elk groups was 77 percent. No functional responses of wolf predation rates to elk numbers were detected in

the prey-dependent and ratio-dependent models.
Project Activity in 1999: Carrie completed her course work and began analyzing her data.
Anticipated Completion Date: May 2000

Graduate Student: Dan Stahler (Master of Science candidate)
Committee Chair: Dr. Bernd Heinrich, University of Vermont
Title: Common ravens (*Corvus corax*) following gray wolves (*Canis lupus*) as a foraging strategy in Yellowstone National Park
Project Narrative: Associations between ravens and wolves, coyotes, elk, and randomly-selected sites were evaluated. Ravens preferentially associated with wolves, but not with other species or random sites. Ravens were also socially facilitated by each other at wolf kills. Data suggested a long-shared evolutionary history between wolves and ravens.
Project Activity in 1999: Dan completed his data collection, assisted wolf project field operations, continued his course work, and began analyzing data.
Anticipated Completion Date: May 2000

Graduate Student: Linda Thurston (Master of Science candidate)
Committee Chair: Dr. Jane Packard, Texas A & M University
Title: Denning behavior of wolves on Yellowstone's northern range
Project Narrative: Currently there are no definitive answers as to how and to what extent breeding and non-breeding pack members provide care to wolf pups. To address this question, den attendance of four wolf packs was examined for two years (1997–98), using both around-the-clock telemetry locations and visual observations at dens. Breeding females usually attended the den more often than the male in the first 10 weeks, *i.e.,* during the nursing and weaning phase. Most non-breeding pack members attended the den approximately 50 percent of the time, and their attendance was more constant over time than that of the breeding wolves.
Project Activity in 1999: Linda completed her course work and began analyzing her data.
Anticipated Completion Date: June 2000

Douglas Smith

Members of the Crystal Creek pack in Pelican Valley.

Other Collaborative Research

Topic	Lead Collaborator	Institution
Wolf-cougar interactions	Howard Quigley, Toni Ruth	Hornocker Wildlife Institute
Wolf-coyote interactions	Bob Crabtree, Jennifer Sheldon	Yellowstone Ecosystem Studies
Wolf-elk relationships in the Firehole watershed	Bob Garrott, Rose Jaffe	Montana State University
Wolf stress hormones	Scott Creel, Jennifer Sands	Montana State University
Wolf-scavenger relationships	Wayne Getz, Chris Wilmers	California State University, Berkeley
Wolf-carnivore-human interactions	Howard Quigley	Hornocker Wildlife Institute
	Charles Schwartz	Interagency Grizzly Bear Study Team
	Dan Tyers	U.S. Forest Service, Gallatin National Forest Gardiner District
	Kevin Fry	Montana Dept. of Fish, Wildlife and Parks

Public Involvement

Volunteer Program

Twenty-two volunteers worked a total of 15,408 hours in 1999, worth $183,047 at the GS-5 level (see Appendix). Volunteer positions continued to be highly competitive. Chosen volunteers received subsidized or free housing and a $200/month food stipend.

More positions are available during our winter field season. In some cases, a minimum stay of three months is required. Interested persons should mail a cover letter and resumé to the Yellowstone Wolf Project, P.O. Box 168, Yellowstone National Park, Wyoming 82190.

Visiting Scholars Program

The visiting scholars program was established in 1995 with the intent of bringing a distinguished individual to Yellowstone each year to help with some aspect of the wolf program. The park provides housing and office space. Specific objectives and projects are worked out before arrival in Yellowstone. In return, the visiting scholars have helped in fieldwork and data analyses, and have presented their own work in seminars to Yellowstone employees.

This year marked the fourth year visiting scholars assisted Yellowstone. Bernd Heinrich from the University of Vermont was scheduled for December 1999, but conflicts forced him to reschedule for February 2000. Bernd is well known worldwide for his pioneering work with ravens. Bernd advises one of our graduate students, Daniel Stahler, who is studying whether ravens actually follow wolves to their kills. This question has generated much anecdotal speculation, but the openness of the Yellowstone landscape provides an opportunity to obtain quantitative data.

Acknowledgments

As in years past, the Yellowstone Wolf Project benefited from the help of many individuals in 1999. We are all still amazed at the interest and willingness of others to assist with our efforts on wolf recovery, management, and research. It was clear to us long ago that we would not be able to operate at the level we do were it not for this help. Again, we are indebted to many, and will not attempt to list everyone for fear of inadvertently leaving someone out.

We are thankful for the contributions from individuals, corporations, and foundations that donated funds to the various needs and causes of the Yellowstone Wolf Project. Tami Blackford, Sue Consolo Murphy, and Mary Ann Franke edited and produced this report. We appreciate their input and recognize the critical nature of their involvement.

Douglas Smith

Although the Druid Peak pack spends most of the winter in Lamar Valley, they occasionally make forays elsewhere when low snowfall delays the elk migration at higher elevations. During one such trip in December, they were photographed on Specimen Ridge at approximately 8,400 feet.

Appendix

Yellowstone Wolf Project Volunteer Roster, 1999

Name	Period of Involvement	Hours
Brewster, Eric	02/17/1999–05/31/1999	128
Buchwald, Robert	02/22/1999–05/27/1999 and 11/05/1999–12/16/1999	1,096
Chin, Susan	04/03/1999–07/18/1999 and 09/15/1999–12/16/1999	1,600
Dawn, Deanna	02/22/1999–04/02/1999	320
Evans, Shaney	01/01/1999–01/22/1999	176
Holmquist, Brett	02/22/1999–04/02/1999	320
Honness, Kevin	03/11/1999–03/20/1999	80
Jacobs, Amy	01/01/1999–03/22/1999 and 06/15/1999–07/15/1999 and 10/15/1999–12/16/1999	1,160
Lineweaver, Deb	04/03/1999–08/10/1999	1,040
MacNulty, Dan	01/17/1999–03/28/1999	568
Marstall, Heather	02/22/1999–06/30/1999	1,032
McDonald, Jennifer	02/22/1999–04/02/1999	320
Passmore, Bruce	02/27/1999–04/02/1999	280
Peer, Melissa	11/07/1999–12/16/1999	320
Pils, Andy	02/22/1999–04/02/1999	320
Schaefer, Carrie	01/01/1999–01/22/1999 and 08/02/1999–08/16/1999	296
Stahler, Dan	01/01/1999–01/16/1999 and 05/25/1999–12/19/1999	1,800
Strong, Laura	02/22/1999–04/02/1999	320
Thurston, Linda	01/07/1999–12/16/1999	2,752
Varley, Nathan	03/01/1999–03/10/1999	80
Wilson, Jason	04/03/1999–08/10/1999	1,040
Zieber, Tom	11/02/1999–12/16/1999	360
Total Volunteer Hours Worked		**15,408**

Douglas Smith

Members of the Rose Creek pack.

Publications

Bangs, E. E., S. H. Fritts, J. A. Fontaine, D. W. Smith, K. M. Murphy, C. M. Mack, and C. C. Niemeyer. 1999. Status of gray wolf restoration in Montana, Idaho, and Wyoming. Wildlife Society Bulletin 26:785–798.

Smith, D. W., W. G. Brewster, and E. E. Bangs. 1999. Wolves in the greater Yellowstone ecosystem: Restoration of a top carnivore in a complex management environment. Pages 103–125 in T. W. Clark, A. P. Curlee, S. C. Minta, and P. M. Kareiva, editors. Carnivores in ecosystems: The Yellowstone experience. Yale University Press, New Haven, CT.

Douglas Smith

Brothers #193 and #194 are among the surviving members of the declining Crystal Creek pack. This pack had only one surviving pup in 1999.

Nonprofit Organizations Supporting Yellowstone Wolf Restoration

Wolf restoration in Yellowstone continues to depend on the financial assistance of many individuals and organizations. Most or all contributions to the following organizations will provide direct funding to Yellowstone wolf restoration or help pay for needed professional services.

Nonprofit Government Affiliates Accepting Direct Donations for Yellowstone Wolves

- Yellowstone Park Foundation Wolf Fund
  The Yellowstone Park Foundation
  37 East Main Street, Suite 4
  Bozeman, Montana 59715
  406-586-6303

- National Park Foundation
  1101 17th Street NW, Suite 1102
  Washington, D.C. 20036
  202-785-4500

- National Fish and Wildlife Foundation
  1120 Connecticut Avenue NW, Suite 900
  Washington, D.C. 20036

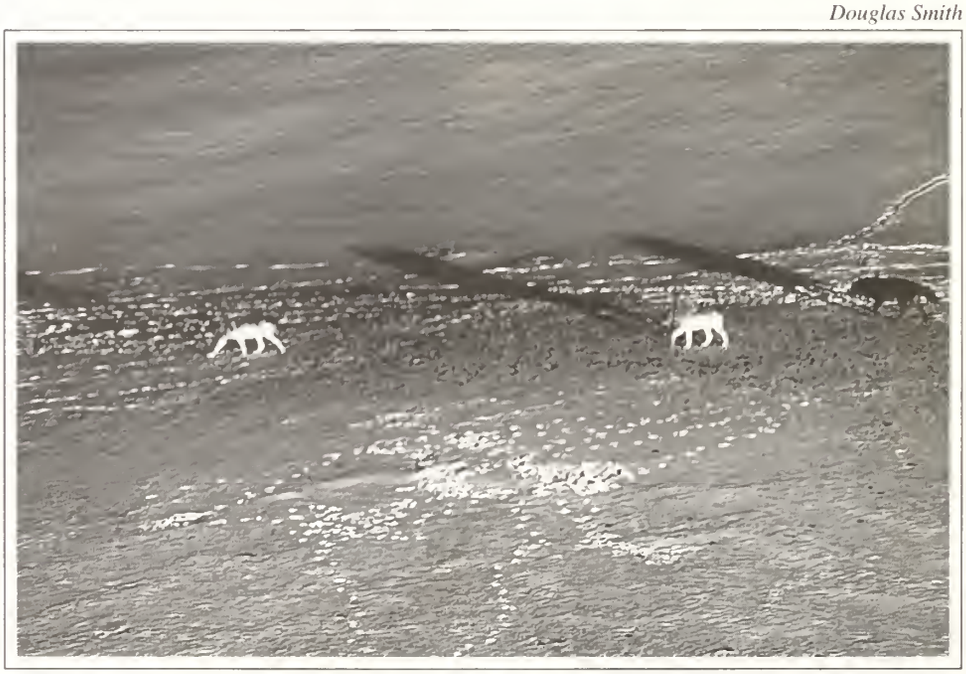
Nonprofit Organizations Working on Behalf of Yellowstone Wolves

- Defenders of Wildlife
  Northern Rockies Regional Office
  1534 Mansfield Avenue
  Missoula, Montana 59801
  406-549-0761

- International Wolf Center
  5930 Brooklyn Boulevard
  Minneapolis, Minnesota 55429
  218-365-4695

- The Wildlife Science Center
  5463 West Broadway
  Forest Lake, Minnesota 55025
  612-464-3993

Douglas Smith



Three members of the Crystal Creek pack in Pelican Valley, early winter 1999.